Space Shuttle Atlantis (STS-135) - Exhaust speed

This sequence of images shows the historic launch of the Space Shuttle Atlantis (STS-135) on July 8, 2011 at 11:29 a.m. EDT, from launch pad 39A at the NASA Cape Canaveral Space Center.

From bottom to top, the image times are 11:29:12.0, 11:29:12.5, and 11:29:13.0. The length of the space shuttle is 37 meters from its pointed top end to the base of its rocket nozzles.

A rocket moves forward by throwing mass out its rocket engines as fast as possible. It does NOT move forward by 'pushing against' the ground as a popular misconception might suggest.

By ejecting thousands of pounds of gas every second, a rocket motor produces the thrust needed to lift a payload and move it in the opposite direction to its exhaust.

The plume of gas is ejected at high speed from the Shuttle main engines and makes a right-angle turn as it is vented horizontally across the gantry platform.

Problem 1 - Using a millimeter ruler, what is the scale of each image in meters/mm?

Problem 2 - How far did the leading edge of the exhaust plume travel between the top and bottom images?

Problem 3 - What was the speed of the exhaust plume in A) meters/sec? B) kilometers/hr? C) miles/hr?

Problem 1 - Using a millimeter ruler, what is the scale of each image in meters/mm?

Answer: The Shuttle measures about 13 millimeters in length on an ordinary reproduction of this 8.5 x 11-inch page, so the scale is **2.8 meters/mm**.

Problem 2 - How far did the leading edge of the exhaust plume travel between the top and bottom images?

Answer: For example, students might measure the distance from the tip of the cloud and the left-edge of the image. Top Image = 5 mm. Bottom image = 15 mm ,so the distance traveled is 10 millimeters or from the scale factor, 10 x 2.8 = **28 meters**.

Problem 3 - What was the speed of the exhaust plume in A) meters/sec? B) kilometers/hr? C) miles/hr?

Answer: A) The time difference between the top and bottom images is 11:29:13.0 - 11:29:12.0 = 1 second. The average speed would be 28 meters/1 sec = **28 meters/sec.**

B) 28 meters/sec x (1 km/1000 meters) x (3600 sec / 1 hr) = **100 km/hr**.

C) 100 km/hr x (0.62 miles / 1 km) = **62 miles per hour**.